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THE MASSIVE STAR NEWSLETTER

formerly known as the hot star newsletter

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CONTENTS OF THIS NEWSLETTER:

News

Special Issue on "Evolved Massive Stars in Transition Phases"

We would like to draw the attention of the massive star community to the call for papers for a Special Issue on "Evolved Massive Stars in Transition Phases". This issue is aimed at providing a platform for recent results and new ideas in the field.

The post-main sequence evolution of massive stars is one of the big open issues in modern astronomy. On their evolutionary paths, crossing the region of the classical blue supergiants, all the way up to the final supernova explosion, massive stars pass through several transition phases (B[e] supergiants, red supergiants, yellow hypergiants, luminous blue variables, and Wolf-Rayet stars), in which they often undergo strong mass loss. The physical mechanisms behind it and the amount of material ejected, both in form of asymmetric, steady winds or violent episodic eruptions, are currently unknown but crucial to understand stellar evolution. Recent advances in both numerical modeling techniques and high-quality observations will provide the key physical ingredients for the next generation of evolutionary and wind models. We invite investigators to contribute to original research articles as well as review articles that will stimulate the continuing effort to understand both the classical blue supergiants and massive stars in transition phases. We are interested in articles that explore aspects of evolutionary connections, the mass-loss behavior, the triggering mechanisms for variability and mass eruptions, the interaction of the ejected material with the environment, and dust production from both observational and modeling perspectives. Potential topics include, but are not limited to:

1. Origin of the variability seen in classical blue supergiants and evolved massive stars in transition phases, focusing in particular on the role of the high luminosity and proximity to the Eddington limit, pulsations, rotation, and magnetic fields

2. Insights from high-quality spectroscopic, photometric, polarimetric, and interferometric data into reliable timescales of the variabilities and their influence throughout the evolution of massive stars

3. The shape of the circumstellar environment and the feedback of the interstellar medium to the variable mass loss and eruptions, and how studies on the stellar environments improve our knowledge about the history of the gas and the evolution of these stars

4. Evidences of evolutionary connections (progenitors, fates) between different transition phases

5. Role of binarity in the evolution of massive stars, and the consequences of binary interactions for the surroundings

All submissions will be refereed. More details on the schedule, and information on the submission process can be found at the web-address below.

On behalf of the editors
Michaela Kraus, Lydia Cidale and Jose Groh

Weblink: http://www.hindawi.com/journals/aa/si/839059/cfp/

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PAPERS

Abstracts of 7 accepted papers

Herschel imaging and spectroscopy of the nebula around the luminous blue variable star WRAY 15-751

C. Vamvatira-Nakou, D. Hutsemekers, P. Royer, Y. Naze, P. Magain, K. Exter, C. Waelkens, M. A. T. Groenewegen

ULg, ULg, KUL, ULg, ULg, KUL, KUL, ROB

We have obtained far-infrared Herschel PACS imaging and spectroscopic observations of the nebular environment of the luminous blue variable WRAY 15-751. These images clearly show that the main, dusty nebula is a shell of radius 0.5 pc and width 0.35 pc extending outside the H-alpha nebula. They also reveal a second, bigger and fainter dust nebula, observed for the first time. Both nebulae lie in an empty cavity, likely the remnant of the O-star wind bubble formed when the star was on the main sequence. The kinematic ages of the nebulae are about 20000 and 80000 years and each nebula contains about 0.05 Msun of dust. Modeling of the inner nebula indicates a Fe-rich dust. The far-infrared spectrum of the main nebula revealed forbidden emission lines coming from ionized and neutral gas. Our study shows that the main nebula consists of a shell of ionized gas surrounded by a thin photodissociation region illuminated by an "average" early-B star. The derived abundance ratios N/O=1.0+/-0.4 and C/O=0.4+/-0.2 indicate a mild N/O enrichment. We estimate that the inner shell contains 1.7+/-0.6 Msun of gas. Assuming a similar dust-to-gas ratio for the outer nebula, the total mass ejected by WRAY 15-751 amounts to 4+/-2 Msun. The measured abundances, masses and kinematic ages of the nebulae were used to constrain the evolution of the star and the epoch at which the nebulae were ejected. Our results point to an ejection of the nebulae during the RSG evolutionary phase of an ~ 40 Msun star. The presence of multiple shells around the star suggests that the mass-loss was not a continuous ejection but rather a series of episodes of extreme mass-loss. Our measurements are compatible with the recent evolutionary tracks computed for an 40 Msun star with little rotation. They support the O-BSG-RSG-YSG-LBV filiation and the idea that high-luminosity and low-luminosity LBVs follow different evolutionary paths.

Reference: accepted for publication in A&A
Status: Manuscript has been accepted

Weblink: http://fr.arxiv.org/abs/1307.0759

Comments:

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DETECTION OF THE COMPRESSED PRIMARY STELLAR WIND IN ETA CARINAE

M. Teodoro (1,2), T. I. Madura (1,3), T. R. Gull (1), M. F. Corcoran (4,5), and K. Hamaguchi (4,6)

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A series of three HST/STIS spectroscopic mappings, spaced approximately one year apart, reveal three partial arcs in [Fe II] and [Ni II] emissions moving outward from eta Carinae. We identify these arcs with the shell-like structures, seen in the 3D hydrodynamical simulations, formed by compression of the primary wind by the secondary wind during periastron passages.

Reference: To appear in ApJ Letters
Status: Manuscript has been accepted

Weblink: http://arxiv.org/abs/1307.3244

Comments:

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Low-amplitude rotational modulation rather than pulsations in the CoRoT B-type supergiant HD 46769

C. Aerts, S. Simon-Diaz, C. Catala, C. Neiner, M. Briquet, N. Castro, V.S. Schmid, M. Scardia, M. Rainer, E. Poretti, P.I. Papics, P. Degroote, S. Bloemen, R.H. Oestensen, M. Auvergne, A. Baglin, F. Baudin, E. Michel, R. Samadi

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{We aim to detect and interpret photometric and spectroscopic variability of the bright CoRoT B-type supergiant target HD,46769 ($V=5.79$). We also attempt to detect a magnetic field in the target.} {We analyse a 23-day oversampled CoRoT light curve after detrending, as well as spectroscopic follow-up data, by using standard Fourier analysis and Phase Dispersion Minimization methods. We determine the fundamental parameters of the star, as well as its abundances from the most prominent spectral lines. We perform a Monte Carlo analysis of spectropolarimetric data to obtain an upper limit of the polar magnetic field, assumping a dipole field.} {In the CoRoT data, we detect a dominant period of 4.84,d with an amplitude of 87,ppm, and some of its (sub-)multiples. Given the shape of the phase-folded light curve and the absence of binary motion, we interpret the dominant variability in terms of rotational modulation, with a rotation period of 9.69,d. Subtraction of the rotational modulation signal does not reveal any sign of pulsations. Our results are consistent with the absence of variability in the Hipparcos light curve. The spectroscopy leads to a projected rotational velocity of 72$pm 2$,km,s^{-1} and does not reveal periodic variability nor the need to invoke macroturbulent line broadening. No signature of a magnetic field is detected in our data. A field stronger than $sim 500$,G at the poles can be excluded, unless the possible non-detected field were more complex than dipolar.} {The absence of pulsations and of macroturbulence of this evolved B-type supergiant is placed into context of instability computations and of observed variability of evolved B-type stars.}

Reference: Accepted for publication in A&A
Status: Manuscript has been accepted

Weblink: http://arxiv.org/abs/1307.5791

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The XMM-Newton EPIC X-ray Light Curve Analysis of WR 6

R. Ignace, K.G. Gayley, W. R. Hamann, D. P. Huenemoerder, L. M. Oskinova, A. M. T. Pollock, M. McFall

ETSU, U of Iowa, U of Potsdam, MIT, U of Potsdam, ESA, Ohio State U

We obtained four pointings of over 100 ks each of the well-studied Wolf-Rayet star WR 6 with the XMM-Newton satellite. With a first paper emphasizing the results of spectral analysis, this follow-up highlights the X-ray variability clearly detected in all four pointings. However, phased light curves fail to confirm obvious cyclic behavior on the well-established 3.766 d period widely found at longer wavelengths. The data are of such quality that we were able to conduct a search for "event clustering" in the arrival times of X-ray photons. However, we fail to detect any such clustering. One possibility is that X-rays are generated in a stationary shock structure. In this context we favor a co-rotating interaction region (CIR) and present a phenomenological model for X-rays from a CIR structure. We show that a

CIR has the potential to account simultaneously for the X-ray variability and constraints provided by the spectral analysis. Ultimately, the viability of the CIR model will require both intermittent long-term X-ray monitoring of WR 6 and better physical models of CIR X-ray production at large radii in stellar winds.

Reference: to appear in ApJ
Status: Manuscript has been accepted

Weblink: http://arxiv.org/abs/1307.7074

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Probing the ejecta of evolved massive stars in transition: A VLT/SINFONI K-band survey

M.E. Oksala(1), M. Kraus(1), L.S. Cidale(2,3), M.F. Muratore(2,3), M. Borges Fernandes(4)

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Massive evolved stars in transition phases, such as Luminous Blue Variables (LBVs), B[e] Supergiants (B[e]SGs), and Yellow Hypergiants (YHGs), are not well understood, and yet crucial steps in determining accurate stellar and galactic evolution models. The circumstellar environments of these stars reveal their mass-loss history, identifying clues to both their individual evolutionary status and the connection between objects of different phases. Here we present a survey of 25 such evolved massive stars (16 B[e]SGs, 6 LBVs, 2 YHGs, and 1 Peculiar Oe star), observed in the K-band with the Spectrograph for INtegral Field Observation in the Near-Infrared (SINFONI; R = 4500) on the ESO VLT UT4 8 m telescope. The sample can be split into two categories based on spectral morphology: one group includes all of the B[e]SGs, the Peculiar Oe star, and two of the LBVs, while the other includes the YHGs and the rest of the LBVs. The difference in LBV spectral appearance is due to some objects being in a quiescent phase and some objects being in an active or outburst phase. CO emission features are found in 13 of our targets, with first time detections for MWC 137, LHA 120-S 35, and LHA 115-S 65. From model fits to the CO band heads, the emitting regions appear to be detached from the stellar surface. Each star with ^12CO features also shows ^13CO emission, signaling an evolved nature. Based on the level of ^13C enrichment, we conclude that many of the B[e]SGs are likely in a pre-Red Supergiant phase of their evolution. There appears to be a lower luminosity limit of log L/L_solar = 5.0 below which CO is not detected. The lack of CO features in several high luminosity B[e]SGs and variability in others suggests that they may in fact be LBV candidates, strengthening the connection between these two very similar transition phases.

Reference: To appear in A&A.
Status: Manuscript has been accepted

Weblink: http://arxiv.org/abs/1308.2103

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Grids of stellar models with rotation - III. Models from 0.8 to 120 M⊙ at a metallicity Z = 0.002

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Aims. We study the impact of a subsolar metallicity on various properties of non-rotating and rotating stars, such as surface velocities and abundances, lifetimes, evolutionary tracks and evolutionary scenarios.

Methods. We provide a grid of single star models covering a mass range from 0.8 to 120 M⊙ with an initial metallicity Z = 0.002 with and without rotation. We discuss the impact of a change in the metallicity by comparing the current tracks with models computed with exactly the same physical ingredients but with a metallicity Z = 0.014 (solar).
Results. We show that the width of the main-sequence (MS) band in the upper part of the Hertzsprung-Russell diagram (HRD), for luminosity above log(L/L⊙) > 5.5, is very sensitive to rotational mixing. Strong mixing significantly reduces the MS width. We confirm, but here for the first time on the whole mass range, that surface enrichments are stronger at low metallicity provided that comparisons are made for equivalent initial mass, rotation and evolutionary stage. We show that the enhancement factor due to a lowering of the metallicity (all other factors kept constant) increases when the initial mass decreases. Present models predict an upper luminosity for the red supergiants (RSG) of log (L/L⊙) around 5.5 at Z = 0.002 in agreement with the observed upper limit of RSG in the Small Magellanic Cloud. We show that models using shear diffusion coefficient calibrated to reproduce the surface enrichments observed for MS B-type stars at Z = 0.014 can also reproduce the stronger enrichments observed at low metallicity. In the framework of the present models, we discuss the factors governing the timescale of the first crossing of the Hertzsprung gap after the MS phase. We show that any process favouring a deep localisation of the H-burning shell (steep gradient at the border of the H-burning convective core, low CNO content) and/or the low opacity of the H-rich envelope favour a blue position in the HRD for the whole or at least a significant fraction of the core He-burning phase.

Reference: Astronomy and Astrophysics
Status: Manuscript has been accepted

Weblink: http://arxiv.org/abs/1308.2914

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GYRE: An open-source stellar oscillation code based on a new Magnus Multiple Shooting Scheme

R. H. D. Townsend, S. A. Teitler

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We present a new oscillation code, GYRE, which solves the stellar pulsation equations (both adiabatic and non-adiabatic) using a novel Magnus Multiple Shooting numerical scheme devised to overcome certain weaknesses of the usual relaxation and shooting schemes appearing in the literature. The code is accurate (up to 6th order in the number of grid points), robust, efficiently makes use of multiple processor cores and/or nodes, and is freely available in source form for use and distribution. We verify the code against analytic solutions and results from other oscillation codes, in all cases finding good agreement. Then, we use the code to explore how the asteroseismic observables of a 1.5 Msun star change as it evolves through the red-giant bump.

Reference: MNRAS, in press
Status: Manuscript has been accepted

Weblink: http://www.astro.wisc.edu/~townsend/gyre/

Comments: Website includes preprint, source code, & documentation

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Abstracts of 1 conference proceedings

Magnetic fields in O stars

Y. Naze

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Over the last decade, large-scale, organized (generally dipolar) magnetic fields with a strength between 0.1 and 20 kG were detected in dozens of OB stars. This contribution reviews the impact of such magnetic fields on the stellar winds of O-stars, with emphasis on variability and X-ray emission.

Reference: Invited review at "Putting A-stars into context" (June 2013 ; Moscow, Russia)
Status: Conference proceedings

Weblink: http://fr.arxiv.org/abs/1306.6753

Comments:

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MEETINGS

Wind Bubbles, Astrospheres and the Heliosphere: Environments and Cosmic Ray Accelerators

4 - 8 November 2013

Venue: Ruhr-University Bochum, Bochum, Germany

The interdisciplinary workshop will give a synoptic overview of the commonality and differences between astrospheres (or stellar wind bubbles) and the heliosphere, as well as the production and leakage of cosmic rays in such 'Spheres'.
The heliophysical research has reached a state of unprecedented theoretical knowledge, a very detailed modeling and rich high resolution in-situ and remote sensing observations. The astronomical remote sensing and modeling approach also reached a sophisticated level. Because the large-scale modeling in both fields is based on a similar set of (magneto-)hydrodynamic equations, one aim of this workshop is to identify the commonalities and discuss the underlying physics like the influence of neutrals or plasma cooling on the large-scale structure. In addition, the transport of energetic particles, which are naturally involved in the dynamics of the heliosphere, and its extension to astrospheres will be a major topic of the workshop. This workshop is important because it allows to explore and compare physical processes that are fundamental for astrophysical and heliophysical as well as for laboratory plasmas.
The workshop is very timely, because with the present and especially the upcoming observational possibilities to detect the details of astrospherical structures, an understanding and quantitative modeling of the underlying fundamental physical properties is required. Moreover, astrospheres of hot stars can contribute the flux of (sub-)TeV cosmic rays, which is observed by large-area cosmic ray telescopes. Beside the modeling and observation of large-scale astrospherical structures, one of the main topics. Thus the workshop will cover many aspects regarding the large-scale structure of the heliosphere and astrospheres, its observational aspects, as well as the role of the latter as sources of cosmic rays and other energetic particles. This is manifest by the five major workshop topics, namely

* The heliosphere as a special example of an astrosphere
* Astrospheres
* Magnetic fields in and around astrospheres
* Acceleration and leakage of energetic particles from astrospheres
* Latest developments in astrospherical physics (including the heliosphere)

Weblink: http://helio_cr.tp4.rub.de/Astrosphere/home.php

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